

## METHOD FOR PRODUCING ELECTRICAL ENERGY

### CROSS-REFERENCE TO RELATED APPLICATION

5           This application claims priority benefits under Title 35, U.S. Code §119 to  
PCT/DE99/03389 filed October 21, 1999, published as WIPO Publication No. WO  
00/25414 on May 4, 2000, which claims the priority benefits to German Patent  
Application DE 198 48 852.1, filed October 22, 1998, now granted as European Patent  
No. EP 1123578 on August 28, 2002 for the following 19 Countries: AT, BE, CH, CY,  
10   DE, DK, ES, FI, FR, GB, GR, IE, IT, LI, LU, MC, NL, PT, SE.

### STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

Not Applicable

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### REFERENCE TO A "MICROFICHE APPENDIX"

Not Applicable

### BACKGROUND OF THE INVENTION

#### 20   (1) Field of the Invention

          The present invention relates to a process for generating voltages by mechanical  
displacement of electrical charges. More particularly, the charges between two working  
media are separated by triboelectrification or by induced static electricity, one of the two  
media being electrically connected to an electrode and the second working medium being  
25   transferred to another electrode on which the charge is picked up.

#### (2) Description of Related Art

          Devices used in the process of the present invention; see DE 23 36 487 A1 and  
European Patent Application 0229 843 A1 for a description of a prior art electrostatic  
30   generator.

          A process is known for producing electrical energy by friction of certain stiff

dielectric surfaces consisting of different materials against one another, and it is accomplished in a compact device; see European Patent Application 0366591 A1.

The prior art devices which can be used for carrying out the present invention are characterized by the possibility of generating electrical high voltage (up to 15 - 20 MV),  
5 by a low current (up to 10 mA), therefore also by low power. The power of these devices is limited on the one hand by the maximum allowable surface density of charges on a conveyor, the carrier of the charge, on the one hand, and by the speed of mechanical movement of this charge conveyor.

The charge density for its part is limited by the formation of an electrical  
10 discharge on the dielectric surface. The speed of the charge conveyor is limited by the mechanical motion possibilities of the parts of the prior art devices.

The efficiency of these prior art devices are determined mainly by the aerodynamic losses as the charge conveyor is moved mechanically and by the friction of the mechanical system parts among one another. In existing prior art devices this is not  
15 greater than 15-20%.

## SUMMARY OF THE INVENTION

The object of the process of the presently claimed invention is to increase the power and the efficiency of the prior art devices and to enable conversion of the thermal  
20 energy into electrical energy.

In the process of the present invention for producing electrical energy, charges are separated between two working media triboelectrically or electrostatically in an electrostatic generator and are moved away from one another by displacement of the working media under the action of gas flow forces. The gas flow forces perform work  
25 against the Coulomb force, and the charges are routed onto electrodes. The process steps are carried out within the inside volume of a heat pipe with the charge separation and charge displacement taking place using the directed gas flow of the heat pipe. The gas flow entrains one working medium of the electrostatic generator and routes it past the other working medium for charge separation and displacement. One source of the  
30 thermal energy is the use of solar energy.

The advantages which are achieved with the process of the present invention

consist especially in enabling the use of thermal energy of any heater for its direct conversion into electrical energy, high output power and high efficiency.

As a result of the properties of heat pipes, a relatively small temperature difference between vaporizer and condenser sections is sufficient to achieve a high flow velocity of the gaseous working medium of the heat pipes and consequently also high kinetic energy. By means of this kinetic energy, the indicated flow causes triboelectrification of the working media of the electrostatic generator and mechanical separation of charges. In the devices which implement this process thus there are no mechanically moving parts, for which reason all losses of power and efficiency which occur for this reason are prevented. Moreover, in this case the drive of the electrostatic generator does not take place by external mechanical work, but by thermal energy which can even be removed from a small temperature difference.

#### BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

The embodiments of the process are shown in the drawings and are detailed below.

Figure 1 shows an embodiment of the process of the present invention using a fixed device with its indicated orientation in the gravitational field.

Figure 2 shows an embodiment of the process of the present invention using a device which can function at different orientations, in a gravitational field, and also in weightlessness.

Figure 3 shows an embodiment of the process of the present invention in which the working liquid of an electrostatic generator is not electrified at the site of its detachment from the mouth of a feeder nozzle, but at some distance from it by the breakdown of the liquid droplets when they suddenly encounter the grid.

Figure 4 shows an isometric view of the embodiment shown in Figure 1.

Figure 5 shows an isometric view of the embodiment shown in Figure 2.

#### DETAILED DESCRIPTION OF THE INVENTION

All types of devices for enablement of the process of the present invention contain a heat pipe 1 and a generator 2. The heat pipe has a working medium in the liquid phase,

i.e., the working liquid 3 which is vaporized to the gaseous phase, i.e., the working gas 4, and a capillary insert 5. The generator 2 contains the solid working medium 6 of the generator 2, the liquid working medium 7 of the generator 2, the pick-up electrode (grid) 8 for charge pick-up, the external electrodes 9a and 9b and the loop 10 for return of the liquid working medium 7.

When a temperature gradient builds up between the vaporizer 11 and the condenser 12 of the heat pipe 1, the working liquid 3 of the heat pipe, vaporizes in the vaporizer on its capillary structure 5a. At the same time the working gas 4 of the heat pipe 1 condenses on the capillary structure 5a of the capillary insert 5 of the condenser 12 of the heat pipe 1. The working liquid 3 travels via the capillary insert 5 out of the condenser 12 back into the vaporizer 11.

It is necessary for the operation of the process of the present invention that the latent heat of vaporization in the first phase of the process is supplied to the working liquid 3 in vaporizer 11 of the heat pipe and the resulting working vapor is removed from vaporizer 11 and flows to condenser 12 during the second phase. This process can also be carried out at a very small temperature difference.

The volume of the working liquid 3 of the heat pipe in the vaporizer 11 increases suddenly and as a result the pressure of the working gas 4 in the vaporizer 11 does likewise. The volume and the pressure of the working gas 4 of the heat pipe in the condenser 12 decrease equally suddenly.

Thus, for a small temperature difference in a closed space during the two phases of the process, the increase and decrease of the gas pressure take place simultaneously and uninterruptedly in this closed space; these phases of the process are spatially separated, proceed with different signs, and are explosive according to their physical properties. This leads to formation of a high speed gas flow from the vaporizer into the condenser. In doing so, the thermal energy A which is supplied to the heat pipe is converted into kinetic energy in the molecules in the gas flow B and can be converted further into other types of energy, for example, into electrical energy C.

The solid working medium 6 and the liquid working medium 7 of the generator 2 are accommodated within the heat pipe 1, roughly at the location of the maximum flow of the working gas 4 of the heat pipe, directly behind the diaphragm 13. The diaphragm 13

concentrates the gas flow from the vaporizer 11 into the condenser 12. The solid working medium 6 is fixedly attached with respect to the heat pipe and is connected to electrode 9b.

The liquid working medium 7 is supplied to the interior of the heat pipe via the feeder 14, charge separation and charge displacement taking place using the directed gas flow of the heat pipe, which flow entrains liquid droplets and routes them past the other working medium 6 resulting in charge separation and displacement.

Subsequently the charge is picked up on the external electrode 9a connected to grid 8, quite analogously to the manner in which this takes place in electrostatic generators with solid media.

In one version of operating the process of the present invention shown in Figures 2 and 5, the loop 10 for return of the liquid working medium 7 of the generator 2 is filled with a capillary structure 16. This makes it possible for the device to work regardless of its location in the gravitational field, and also in weightlessness. Here the open surface of the aforementioned capillary structure 16 is housed directly behind the grid of the pick-up electrode 8.

In the embodiments of other versions of the process of the present invention shown in Figures 3, charge separation takes place by the liquid 7 striking the medium 6. Here the medium 6 has the shape of for example a grid. In this case the solid working medium 6 is located at some distance from the insertion site of the feeder 14 into the interior of the heat pipe as shown in Figure 3. The droplets of the medium 7 before striking the medium 6 acquire a certain kinetic energy which is expended for charge separation. After impact the charged droplets are carried on further with the gas flow of the heat pipe 4 to the pick-up electrode 8.

The gases which are not condensing and which remain in the heat pipe (for example, air and also vapors of the working liquid 7 of the generator 2, which in a closed space, are inevitably combined with the liquid 7, which has a free surface) are pushed away by the working gas 4 of the heat pipe to one of the ends of the pipe in the first seconds of operation of the heat pipe, and form a gas cushion 15.

In the geometry of the heat pipe and the electrode 8 for the charge pick-up (Figures 1-5), this gas cushion 15 to a certain extent thermally insulates the pick-up

electrode 8 and the wall 20 of the heat pipe adjoining it. Therefore, the temperature of the pick-up electrode 8 generally differs from the temperature of the capillary structure 5a of the condenser 12 of the heat pipe.

Since the insertion site of the feeder 14 into the heat pipe is outside of the  
5 vaporizer 11, the same liquid can be used for the working liquid of the heat pipe and of the generator.